EXTAC 886 SD

C2 FOR UNCREWED SYSTEM DRIVEN NMCM OPERATIONS

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REFs: A. ATP-06 VOLUME II

B. STANAG 1454

C. ATP-24 VOLUME II

D. ATP-06 VOLUME I

E. EXTAC 887

1. (NU) PURPOSE

(NU) The purpose of this EXTAC is to provide a C2 structure and procedures for NMCM operations system of uncrewed systems based not excluding legacy NMCM.

utilizing amongst others uncrewed systems.

2.f (NU) INTRODUCTION

(NU) Today NATO NMCM operations C2 structure does not reflect the capability to operate with uncrewed systems, especially when operated by small Autonomous Underwater Vehicle (AUV) teams.

(NU) The present NATO C2 procedures do coordinate tasking and reporting within the NATO command structure, where the NMCM TA (naval mine countermeasures tasking authority) tasks units, that are considered capable of conducting the full cycle of NMCM from detection to countermining. As many small teams operating autonomous sensors are not capable to conduct all sub-missions of detection, classification, identification, and countermining / neutralization, but can only achieve certain submissions, the C2 structure must be broadened to provide the NMCM TA as well as the unit proper formats and structures to task and report sub-missions.

3. (NU) FOCUS AND SCOPE OF THIS EXTAC

(NU) This EXTAC provides a structure and procedure for tasking and reporting, to coordinate multiple assets that are only sub-mission capable and for those that are full cycle capable. It does not intend to supersede current C2 standards, but to widen the options for the NMCM TA.

(NU) This EXTAC shall be a product for continuous evaluation during NMCM exercises and above all the yearly REPMUS exercise, which is an operational experimentation exercise hosted by Portugal, that focusses – in the domain of NMCM – on the conduct of missions utilizing autonomous or automatic systems. In order to enhance interoperability, those systems operated by small teams with limitations in C2 capabilities must be reflected and implemented.

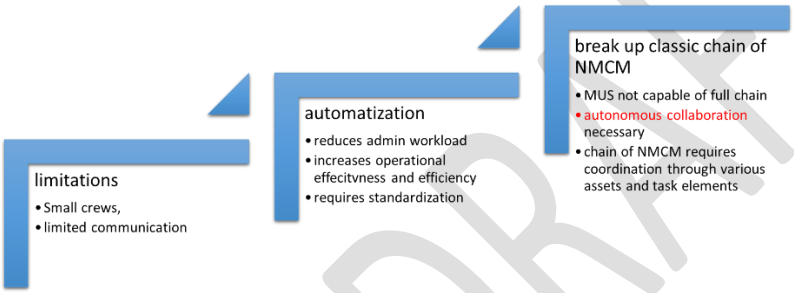

Figure 1 requirements for small teams C2

(NU) This EXTAC is supplemented by Change Proposals to the NMCM APP-11(E) NMW related tasking and reporting formats, mainly OPSTAT UNIT, OPREP NMW, and OPTASK NMW. Recommendations resulting from this EXTAC 886 will be included in additional future change proposals.

(NU) The purpose of this EXTAC is to structure C2 and to provide a specific and granular set of tasking options to task sub-missions of an NMCM cycle and to coordinate uncrewed NMCM missions efficiently and effectively.

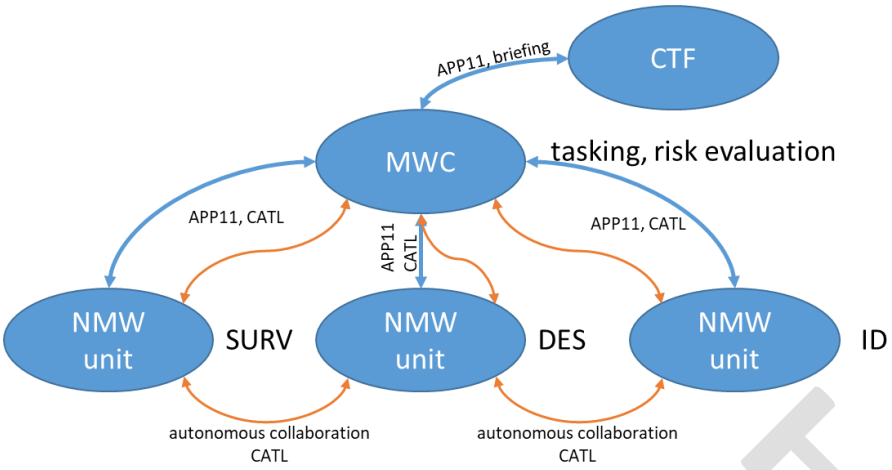

Figure 2 example structure for C2 of submissions

(NU) This EXTAC proposes a partially new terminology for the sub-missions and the products of these to avoid confusion with the legacy terminology. Although this EXTAC only considers tactical information that has an impact on the decision-making process within a NMCM operation. It does not treat the data handling for image-based applications e.g. change detection and Automated Target Recognition (ATR).

(NU) This EXTAC attempts to provide a guideline to automize the C2 process in terms of messaging and coordination to enable the NMCM TA to precisely and effectively control and coordinate the NMW efforts.

4. (NU) PROCEDURE

a) (NU) terminology

This paragraph defines the different sub-missions of the full NMCM cycle that apply to uncrewed NMCM asset deployment.

i) MILA

A MILA (minelike anomaly) is a detected anomaly on the seafloor or in the volume, that indicates a possible threat in the sense of NMW, so it correlates in terms of size and maybe other indicators like shadow, shape or other with the expected or probable threat.

ii) Reacquire

A reacquire is the relocation and reinvestigation of an object or an anomaly.

iii) Survey

A survey is the inspection of the seafloor or the water volume with the intention to detect mine-like anomalies, and results amongst other products in a MILA list. A survey usually prioritizes range over image quality, as its objective is the sole detection of MILAs or the mapping of the seafloor for image-based applications like change detection.

iv) Designation

A designation is the process of investigating an object or an anomaly that either determines an object or an anomaly as a HPDC (high probable designated contact) or as a LPDC (low probable designated contact). This decision is based on the confidence

of the investigation that an object or an anomaly is a mine (or other NMCM threat) or not.

v) Identification

The identification of a HPDC / LPDC or a MILA is the investigation with the necessary means to discriminate mines from other objects with certainty. That requires high quality means of prosecution. It results in either identification as MINE or NOMBO (non-mine minelike bottom object) or a NOMVO (non-minelike volume object).

vi) Countermining

Within the scope of this EXTAC the term countermining concludes all methods to deal with an identified mine, including removal, render safe or recovery.

b) (NU) Sub missions

Especially for SLS (side looking sonars), but also for other sensor types, the following NMCM cycles consisting of sub-missions have been identified. The major trade-off is between the data quality prioritizing on range for a coverage of an area and the amount of information that can be derived from this data to classify contacts. Experience over exercises have shown that splitting the detection (survey) phase, with lower quality but higher range data, from the classification (designation) phase, with high quality data on a small area around the MILEC (MILA) within a reacquire, is increasing the capability to reduce the false alarm rate of classification (designation). The following sub missions are:

i) Survey including Designation
   - ➔ reacquire and Identification
   - ➔ reacquire and Countermine

ii) Survey
   - ➔ reacquire and Designation
   - ➔ reacquire and Identification
   - ➔ reacquire and Countermine

iii) Survey
   - ➔ image based application

iv) Transit
   - ➔ transit task via a defined transit corridor

c) (NU) Stage Numbers

To reflect the separation of phases of a full cycle of NMCM to assign different assets / units to a submission, new stage numbers must be introduced. The formatting of the new stage numbers is aligned with the existing ones of being alphanumeric of either 2 or 3 numbers or letters. The following stage numbers are:

i) X01 survey and plot
ii) X02 survey, designate and plot
iii) X03 reacquire, designate and plot
iv) X04 reacquire, re-designate and plot
v) X05 reacquire, identify and plot
vi) X09 reacquire and countermine
vii) X10 survey and provide image
viii) Y01 transit via transit corridor to mission area
ix) Y02 transit via transit corridor from mission area

d) (NU) Tasking Sequence

Due to physics and environmental conditions greater range is accompanied by loss of quality of the information gained through a survey. Lower quality of information in the data leads to higher false alarm rates, thus to more “unnecessary” identifications which are time consuming. As especially side looking sonars have their best image quality at specific ranges as and other ranges provide only limited quality, the designation of HPDCs, that would require an identification will be either increasing the chances to miss an actual mine or create higher false alarms that will ultimately decrease efficiency of mission conduct. So, efficiency may be increased by splitting the survey and designation phase so that ranges can be optimized for survey or for designation. So, survey and plot should be followed by reacquire, designate, and plot for those systems to which the above described applies.

In case of stage X10 the unit must provide the (sonar) image to the staff element, that must be enabled to consume and analyze the data for the necessary application.

So the NMCM TA issues tasks to gather information and reports by the tasked units. That can be either processed data or sensor data. These different types of data must be treated differently.

e) (NU) NMCM data handling

i) tactical data

Tactical data is the output from analyzed sensor data and is composed of information about a certain geographical position with attributes like contact information. This can be transmitted in a text format.

ii) sensor data

Sensor data is the technically processed raw (formatted) imagery from the sensor without specific analysis.

iii) contact management

The NMCM TA has to provide a contact management policy, that not only collects tactical information and contact data, but also correlates and fuses contacts if they are

- within a defined range
- and show alike attributes

iv) The contact management policy has to define input, output and procedures within the NMW OPDIR and disseminate the current contact information to all subordinate task elements. The receiving task elements have to adapt their contact management accordingly.

Contact management must ensure, that the same object is monitored and correlated through its lifespan, beginning as a MILEC / MILA, MILCO / NON-MILCO or LPDC / HPDC, mine / NOMBO. Contact reference numbers and mine reference numbers apply accordingly.

v) EXTAC 887 defines specifics about data handling in NMW operations.

f) lines of communication

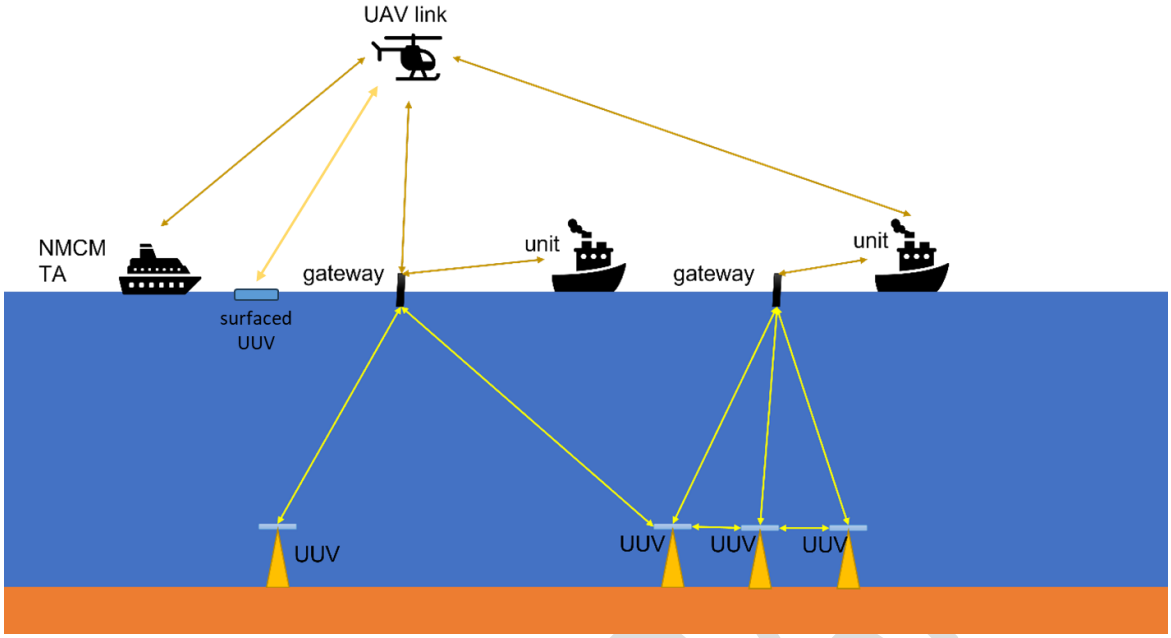

Figure 3 example communication links

In the example of Figure 3 the communication lines are depicted. Below surface acoustic communication are standard today but might be substituted by laser or other means. So far, these links are limited in bandwidth and/or range. Subsurface communication is therefore limited to text type messaging, while the electromagnetic spectrum (including light) above the surface can facilitate higher bandwidth transmissions. Range can be increased by utilizing relay stations, e.g., UAVs and USV's acting as a gateway (which will be at least their own asset, but also may be its own or a different unit).
The communication links need to be automatized to reduce operator workload and to harden transmission safety.

g) water space management

NMCM TA has to define launch and recovery points (LRP) and corridors for uncrewed system transit from and to mission areas. They have to be separated laterally and/or vertically by direction. A corridor should be at least 6 times the size of the largest navigational error of the available uncrewed assets over the distance to be sailed.

Corridors need to be one way traffic only and separated by at least 6 times the size of the largest navigational error of the available uncrewed assets over the distance to be sailed.

The transit corridor should pass mission areas with a safety margin to allow turning cycles for equipment active in mission.

The NMCM tasking authority is responsible to organize and task transit corridor movements. This includes definition of entering and leaving points of the transit corridor.

i) naming convention

A transit corridor should be named by the following convention:

T + 2 letter abbreviation for operation area + consecutive count with three numbers, e.g. TSE001

Waypoints should be defined by consecutive letters, e.g. TSE001 A, intermediate waypoints will be defined by the previous waypoint and its distance to it in nautical miles, e.g. TSE001 A5.1.

ii) joining and leaving a transit corridor

joining and leaving a transit corridor must be in the specified depth at the ordered waypoint

iii) defining a transit corridor can be done in the APP-11 NMW OPDIR using the segment NMW Area Details

iv) defining waypoints can be done in the APP-11 NMW OPDIR using the segment NMCM AREA in the set AREAPARA.

v) Ordering a transit should consist of the waypoints that need to be sailed in order to follow the designated route including all junctures, e.g. TSE001A-TSE001B-TSE001C2.4

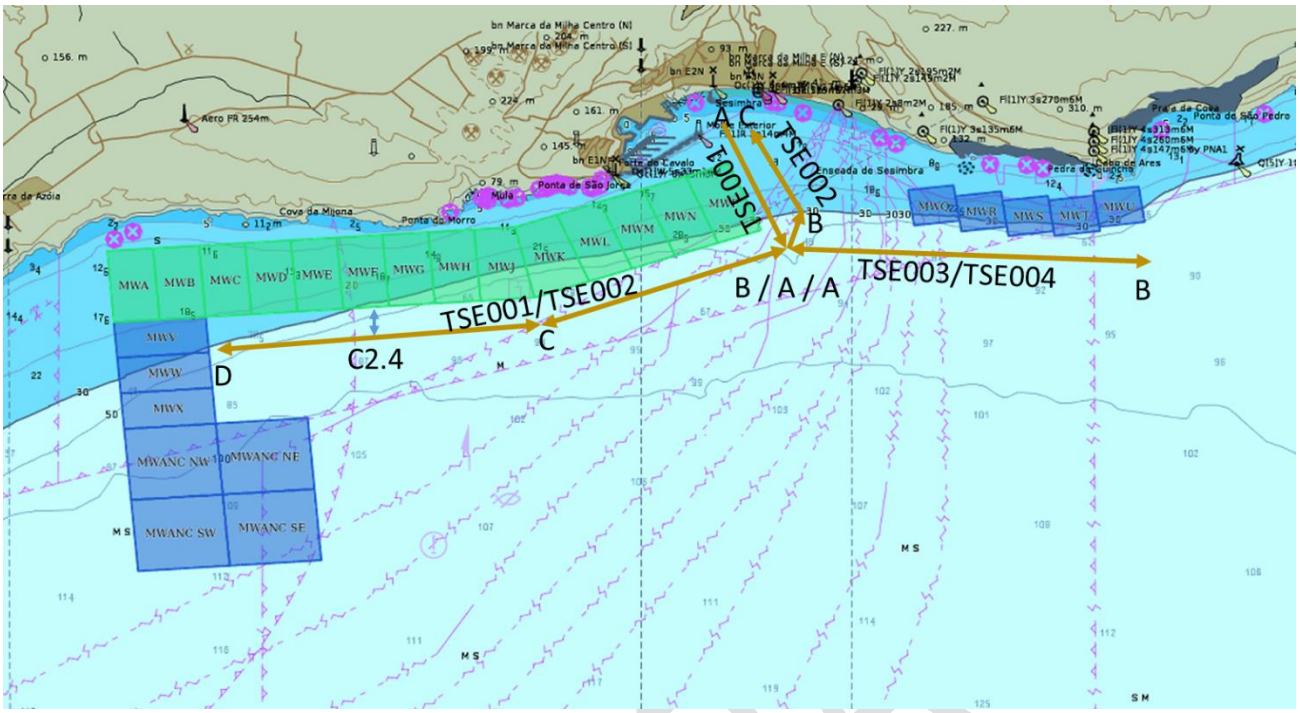

Figure 4 waterspace management example

In this example you can see 4 different transit corridors. TSE001 is defined outbound to the West, TSE003 is defined outbound to the East, starting at TSE001 B. TSE002 is inbound from the West, TSE004 is inbound from the East. TSE001 and TSE002 are separated horizontally only where the vertical separation is not possible due to available water depths, same applies for TSE003 and TSE004.